

Exploration of Pedagogical Interventions to Improve the Outcomes of Hispanics in AP Computer Science

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Abstract – A research project underway at Kean University is exploring pedagogical interventions aimed at improving the outcomes of English Language Learners in Advanced Placement Computer Science. English Language Learners are students who come from non-English speaking homes and backgrounds. With the increasing numbers of Hispanic students in many K-12 classrooms, Spanish is the language most often spoken by English Language Learners. Advanced Placement Computer Science teachers will utilize strategies from Sheltered Instruction, an educational model from English as a Second Language and Bilingual education, in their classrooms. The impact of this approach will be measured by comparing the exam scores of students in the classroom of participating teachers with the 2020 national and state Advanced Placement Computer Science exam scores. Research outcomes of the pedagogical interventions explored will be widely utilized for teaching Computer Science to all English Language Learners, including Hispanics.

Index Terms - Advanced Placement (AP), English Language Learners (ELLs), Hispanics, Sheltered Instruction (SI).

INTRODUCTION

Hispanics, one of the groups with the lowest representation in Computer Science, are the largest ethnic minority in the United States. The U.S. Hispanic population reached a record 59.9 million in 2018 comprising 18% of the total United States population [1]. Since 2014, there has been an upward trend in the participation of Hispanics in computing occupations. However, in 2017, only 7.2% of all computing jobs were held by Hispanics [2] and Hispanic students earned only 7% of bachelor's degrees in computer science [3].

Hispanics accounted for 25 percent of the nation's 54 million K-12 students in 2016, up from 16 percent in 2000 [4]. At the high school level, national participation in Advanced Placement Computer Science A (AP CSA) has increased by 15% and participation in AP Computer Science Principles (AP CSP) has more than doubled since 2017 [5]. Students' performance in both AP CSP and AP CSA has been steadily on the rise with 2019 exam scores of AP CSA students setting a record as the highest to date [6]. Despite the increase in participation, Hispanic students continue to

experience both a higher failure rate and a lower mean score on the AP CSP and AP CSA exams compared to white test takers and the national population of test takers [7], as shown in Tables I and II.

TABLE I

2019 NATIONAL DATA FOR AP CSP TEST TAKERS				
Ethnicity	Mean	Number of Students	Percent of All Test Takers	Pass Rate
White	3.26	42,044	45%	78%
Hispanic	2.61	18,601	20%	54%
All	3.1	94,360	100%	72%

TABLE II

2019 NATIONAL DATA FOR AP CSA TEST TAKERS				
Ethnicity	Mean	Number of Students	Percent of All Test Takers	Pass Rate
White	3.29	27,853	43%	72%
Hispanic	2.5	7,728	12%	47%
All	3.2	64,197	100%	69%

The research project presented here examines the under achievement of Hispanic students on the AP CSA and AP CSP exams through a language lens and explores pedagogical interventions from Sheltered Instruction (SI) as a possible solution. The project, funded by a Google Computer Science Education Research (CS-ER) grant, is an inter-disciplinary collaboration between Kean University's School of Computer Science and Technology in the College of Sciences and the School of Curriculum and Teaching in the College of Education.

Although the project is focused on Hispanic students, it is expected that the results can be applied to improving the outcomes of all English Language Learners (ELLs) in Computer Science.

SECOND LANGUAGE ACQUISITION

Sheltered instruction is based on current research on second language acquisition and language development. Second Language Acquisition theory differentiates between social language and academic language [8]. Social language or BICS (Basic Interpersonal Communication Skills) refers to the language used in everyday social contexts. Academic Language or CALP (Cognitive Academic Language Proficiency) is the language used in classrooms. Research indicates that it takes English Language Learners (ELLs) an

average of three to five years to develop social language proficiency. However, the process of acquiring CALP in English takes longer. For example, data has shown that ELLs that have acquired academic literacy in their first language generally take between five and seven years to achieve academic language proficiency in English. In contrast, ELLs that lack literacy in a first language take seven to ten years (or longer) [9]. Academic English includes language used in textbooks, assignments, class presentations and assessments. Therefore, the length of time required for students to achieve academic English proficiency depends on many factors including first language proficiency and the number of years of schooling in the students' native language [10]. An ELL student may appear fully fluent in English yet struggle with academic language proficiency in the classroom. The barriers that Hispanics are encountering in mastering AP CSA and AP CSP content may be directly related to low academic language proficiency.

Research also indicates that second language acquisition only takes place when instruction includes *comprehensible input* and students' anxiety levels (an affective filter for learning) are low [11]. Teachers can make input comprehensible by designing lessons to include the use of the four language domains of listening, speaking, writing and reading, allowing the use of students' first language in the classroom, and embedding context into instruction [12].

ENGLISH LANGUAGE PROFICIENCY

Federal, state and local policies govern the education of ELLs in the United States. Public schools must identify and provide support for ELL students in order to ensure them equal participation in all educational programs [13]. School districts are required to have procedures in place to identify ELL students and to assess the need for English as a Second Language (ESL) instruction. English Language Proficiency (ELP) tests are used to measure a student's progress annually. Once a student reaches a recommended threshold score on the ELP test, the student can exit the ESL program. Parents can refuse ESL instruction for their children.

One of the most widely used ELP tests is the WIDA Consortium's ACCESS test. The WIDA ELP test score is a composite score measuring student's English Language Proficiency in four domains: reading, writing, speaking and listening [14]. States can set their own guidelines on the cut-off score for proficiency on a scale of 1-6. In New Jersey, the state where the research is being conducted, students are considered proficient with a *composite score* of 4.5 [15]. As a result, students who have a high score in one language domain but low score in some of the other language domains can test out of ESL programs without reaching the language proficiency needed to succeed in the classroom.

SHELTERED INSTRUCTION

Sheltered Instruction (SI) is a research-based instructional framework used across the disciplines. It is used in

mainstream classrooms which include a combination of ELLs and native English speakers or in classrooms with ELLs only. SI is based on second language acquisition and language development research and combines best teaching practices with language scaffolding strategies in the classroom. The following are among the components of Sheltered Instruction [16]:

- Integrating collaborative learning activities which encourage student interaction and academic discussions in the classroom.
- Explicitly teaching the academic language of the discipline in meaningful ways.
- Making input comprehensible by embedding context into instruction, such as using hands-on materials, manipulatives, visuals, video, charts, demonstrations and modeling.
- Including language objectives in addition to content objectives in every lesson to deliberately include the use of the four language domains: listening, speaking, reading and writing in instructional activities.
- Leveraging students' background knowledge by utilizing students' knowledge of their first language as appropriate.
- Utilizing strategies such as sentence frames and stems in the classroom to scaffold language complexity.
- Providing students with strategies that improve their study skills, enhance their comprehension and assist with understanding instructional materials.

Sheltered Instruction was developed in the 1980s. It has become more widely used in the past decade due to the increasing number of ELL students in K-12 classrooms. The original Sheltered Instruction Observation Protocol (SIOP) model was developed and licensed by Pearson Education [17]. Modified versions of the Sheltered Instruction model have been adapted more recently for use in content area classrooms. Although Sheltered Instruction is used throughout the United States across the disciplines, it is rarely, if ever, used in the Computer Science classroom. SI methods are found in teacher education programs for bilingual and ESL teachers. Most computer science teachers are not familiar with SI and focus their efforts on the technical and pedagogical skills needed to teach computing, not on addressing the language literacy skills of their students.

RESEARCH PROJECT

This research project began in the summer of 2019. AP Computer Science teachers from fifteen New Jersey school districts are currently participating in the project. The school districts are demographically diverse and serve a high number of ELLs, most specifically Hispanics.

Professional learning materials have been developed for two full-day and three half-day workshops. The workshops provide the AP CSA and AP CSP teachers with instruction on second language acquisition theory and sensitize the teachers to the importance of language in designing

instruction. The workshops have been developed using a hands-on approach providing opportunities for collaboration and discussion. Lessons from the AP CSA and AP CSP curricula used by the participating teachers have been analyzed to determine the language functions students must master to successfully complete lesson activities and comprehend concepts. Strategies and activities that the teachers can use in AP CS classrooms to scaffold language have been modeled throughout the workshop.

The participating teachers are utilizing the strategies of Sheltered Instruction in their AP CS classrooms throughout the academic year. Working in pairs, the teachers will be collaborating on a model lesson. The collaborating teachers will use the model lesson in their classrooms, with their new SI techniques, and refine the lesson based on their experience. The teachers will share their model lessons and reflections at the last workshop.

RESEARCH QUESTIONS

The project will address three research questions:

- Will AP CS teacher's awareness of language acquisition concepts and the strategies of Sheltered Instruction positively impact instruction in the AP Computer Science classroom?
- Will utilizing Sheltered Instruction strategies improve the outcomes of EL students in AP Computer Science A and AP Computer Science Principles?
- Will utilizing Sheltered Instruction strategies improve the outcome of all student groups in AP Computer Science A and AP Computer Science Principles?

EVALUATION

The AP CSA and AP CSP aggregate exam scores for two groups: Hispanics and all students in the classroom of the participating teachers will be collected during July 2020. The project will be evaluated by comparing the 2020 aggregate AP CSA and AP CSP exam scores of students in the classroom of participating teachers with the results of the 2020 national and state level exam results. The project evaluation is expected to be completed by October 2020.

OBSERVATIONS

The AP CSA and AP CSP teachers participating in the project demonstrated a strong interest and motivation to learn about second language acquisition and strategies to improve the outcomes of their students. Most of the teachers have not previously received any instruction in second language acquisition or Sheltered Instruction except for one teacher from a school which has implemented a district-wide Sheltered Instruction initiative. Since the State of New Jersey has no formal teacher preparation guidelines or credentials for Computer Science teachers, the participating teachers have a range of educational backgrounds and experiences.

There has been an emphasis on increasing the participation of ELLs in AP Computer Science over the last

five years. However, very little research has been conducted on pedagogical interventions to address the under-performance of ELLs to date. Since this proof of concept research project was funded in June 2019, the United States Department of Education awarded \$3 million to the Computer Science Teachers Association (CSTA) for a multi-year research project, Computer Science for English Learners (CSforELs). The project will address improving access and success in AP CSP for ELL students in San Diego County, California, New Mexico and Arizona. The non-profit organization, Code.org, also received a \$4 million dollar grant for a multi-year research project, Equity in AP Computer Science Principles, which is focused on breaking down barriers that result in inequitable access and outcomes for students.

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